

SEPTEMBER 1, 2017



EXPERT REPORT:
PERFLUOROOCTANOIC ACID DEPOSITION
MODELING ANALYSIS
IN NORTH BENNINGTON, VT

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A handwritten signature in blue ink, reading "Gary T. Yoder", is written over a horizontal line.

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1. INTRODUCTION

This Expert Report describes the perfluorooctanoic acid (PFOA) air emission modeling conducted by TRM Environmental Consultants, LLC (TRM), based on emissions from the Chemfab/Saint-Gobain plants located at 101 Water Street in North Bennington, and 108 Northside Drive in Bennington, Vermont, that operated from 1968 through 2001. The study objective was to identify the probable off-site footprint of PFOA deposition. Three emission rate scenarios were used to support modeling and determination of deposition rates ($\text{g}/\text{m}^2/\text{yr}$). This report was prepared with information provided by the Law Offices of Davis & Whitlock, PC; Langrock Sperry & Wool, LLP; and the State of Vermont Department of Environmental Conservation.

To accomplish the study objectives, TRM modeled the Chemfab emissions based on the documented operational conditions for the Chemfab production equipment.

The air dispersion modeling and accompanying Expert Report have been prepared by TRM in support of Sullivan, et al. v Saint-Gobain, filed August 1, 2016, in United States District Court for the Eastern District of Vermont (Civil Action No. 5:16-cv-000125-GWC). Qualifications of the author are provided in the Appendix, with a rate of compensation of 205 dollars per hour.

2. SUMMARY OF QUALIFICATIONS

Mr. Yoder has 26 years of professional air quality experience providing compliance services to the manufacturing, utility, government, and institutional market sectors. Mr. Yoder has a demonstrated ability to resolve complex technical issues, and complete projects on time and within budget. Mr. Yoder is a senior level scientist whose primary areas of technical expertise are air dispersion modeling, regulatory applicability and consultation, emission estimation, air pollution control applications, and emission measurement management. Throughout his career, Mr. Yoder has assisted multiple manufacturing operations with air quality compliance solutions in many states along the east coast. His projects have involved complex air quality issues pertaining to federal NSPS, NESHAP, MACT, PSD, NNSR, and Title V, as well as various state regulations. His specialties include: air dispersion modeling, assessment of emission inventories; compliance auditing; monitoring system design; recordkeeping and reporting system design; air permit application development; air pollution control applications; air emissions and greenhouse gas inventories; and regulatory applicability and consultation.

3. CHEMFAB SITE AND EMISSION CHARACTERISTICS

The Chemfab site location is shown in Figure 1. Site features which dictated model inputs are discussed.

3.1. SITE DESCRIPTION

Chemfab operated at 108 Northside Drive, in Bennington, Vermont, from 1968 to 1978, and at 101 Water Street in North Bennington, Vermont, from 1978 through 2001, when the manufacturing operations were moved to Merrimack, New Hampshire and the North Bennington facility was closed. The Chemfab North Bennington property is located at the intersection Water Street, River Road, and North Bennington Road. It is geographically located 1 mile south of downtown North Bennington and approximately 3.5 miles northwest of downtown Bennington, Vermont as can be seen on Figure 1.

Topography near Chemfab's Water Street plant is considered complex with terrain exceeding emission point heights in close proximity to the facility. The property borders the Walloomsac River flood plain with steep elevation changes bordering the river. For dispersion modeling purposes, the terrain within a 5-km radius of the facility can be classified as complex.

Based on land use approximation using the classification scheme developed by Auer (1978), the North Bennington area can be classified as rural. Therefore, we selected the rural air dispersion modeling curves for this analysis.

4. MODELING METHODOLOGY

Refined air dispersion modeling to determine ambient concentrations or deposition rates requires development of site-specific data from a facility's emissions to develop the model input. This section describes the Chemfab site modeling input selection process.

This analysis involved estimating a deposition rate ($\text{gm}/\text{m}^2/\text{yr}$) of PFOA as particulate matter present in Chemfab's processes at the Northside Drive and Water Street facilities. This was accomplished using the latest version of the US EPA's AERMOD modeling system (version 16216r). AERMOD was selected since the scope for this analysis was to estimate the extent of PFOA deposition and deposition rate based on three PFOA emission rate scenarios from Chemfab's operation. As additional information is produced regarding the quantity of PFOA emitted from the Chemfab process, other models, including a Lagrangian puff model, may be suitable (e.g., post emission steam plume influence). Additionally, the author understands that the Vermont Department of Environmental Conservation – Air Quality and Climate Division (VDEC) completed an air dispersion modeling assessment of Chemfab's PFOA emissions using both AERMOD and a puff model with the model results in relatively good agreement. AERMOD is generally accepted by regulatory agencies and the scientific community for use in air dispersion modeling.

AERMOD is a steady-state, refined dispersion model that incorporates the actual, spatial relationship between sources, receptors, and structures. It can estimate deposition rates from various emission sources and plume types using archived meteorological data. It is an integrated system that includes three modules: a steady-state dispersion module, a meteorological data preprocessor (AERMET), and a terrain preprocessor (AERMAP). This analysis used preprocessed meteorological data provided by the VDEC, and therefore execution of AERMET was not required. The AERMAP preprocessor was used to process digitized terrain in the modeling domain. AERMOD also includes the Plume Rise Model Enhancements (PRIME) algorithm to account for the effects of building downwash on plume behavior. Details on model inputs for this analysis are provided in the sections below.

The following regulatory guidance and documents were followed for this analysis:

- *Guideline on Air Quality Models* (40 CFR Part 51, Appendix W), United States Environmental Protection Agency (USEPA), 2005.
- *Guideline for Determination of Good Engineering Practice Stack Height* (Technical Support Document of the Stack Height Regulations) (Revised), USEPA, EPA-450/4-80/023R, Washington, DC, 1985.
- *User's Guide for the AMS/EPA Regulatory Model* (Revised). USEPA, EPA-454-B-03-001. Research Triangle Park, NC: EPA, Office of Air Quality Planning, and Standards, 2004.
- Wesley, M.L., et al., June 2002, *Deposition Parameterizations for Industrial Source Complex (ICS3) Model*, Environmental Research Division, Argonne National Laboratory.
- Auer, A.H. 1978. "Correlation of Land Use and Cover with Meteorological Anomalies." *Journal of Applied Meteorology*, 17:636-643.

The Universal Transverse Mercator (NAD 83) projection coordinate system was used for all geographical model input (sources, receptors, and structures).

4.1 GEP STACK HEIGHT AND BUILDING DOWNWASH

In simulating air quality impacts from a source, consideration must be given to structures that may be in proximity to emission points that can influence plume behavior. To avoid plume downwash due to nearby structures, the stack must be at a height called good engineering practice (GEP) stack height (H_{GEP}).

However, H_{GEP} is also a limiting factor meaning any portion of the stack greater than H_{GEP} cannot be considered in the air dispersion modeling analysis. The US EPA has defined a GEP stack as the following:

$$H_{GEP} = H_b + 1.5 L$$

where H_b is the building height and L is the lesser of the building height or projected width of the building.

This formula is valid for any structure near the stack that is within a horizontal distance of five times the lesser of the height or projected width of the structure. Note also that the GEP stack height may vary depending on the wind direction, since different structures may influence different wind directions.

A GEP stack height determination for the tower stacks in this analysis was performed using the most recent version of the US EPA Building Profile Input Program (BPIP, Version 04274). BPIP algorithms calculate the directional-dependent building dimensions necessary to model building downwash in the refined modeling analysis from multiple wind directions.

The Water Street tower stacks are characterized as non-GEP and emissions from them are therefore subject to building downwash effects. The Water Street building was modified over the years as new coating towers were introduced and new cupola penthouses added to the roof. For this analysis, the final Water Street structure as it was when it closed in 2002 was assumed for all the years of operation. Figure 2 is a 3D rendition of the Water Street building and emission points as input into the AERMOD model.

Very little historical information is available on the Chemfab's process and exhausts at Northside Drive. Review of the Google Earth[®] satellite image indicates a small building with a single tier having an estimated roof elevation of 18 feet.

Table 1 provides the building structure data input into the model for both Chemfab locations.

4.2. EMISSION POINT INPUTS

Chemfab made several changes during the years of operation at the Water Street location. From the early 1980's, the addition of new processing lines, addition of stacks, and decommissioning older processing lines occurred approximately every two to three years. Changes also included re-routing of process emissions from one tower to another. For the purposes of this analysis and to simplify the approach, the stack arrangement and physical parameters at the 2002 plant closure were assumed for all the years of operation at Water Street. Table 2 shows the emission points input into the model based the most recent VDEC air permitting documents.

Based on several regulatory documents, Chemfab had unpermitted fugitive particulate emissions from its operation at Water Street. Fugitive emissions simulated by air dispersion models result in high, ambient air impacts close to the source of the fugitives. Since the purpose of this analysis was to determine the potential extent of significant deposition, Chemfab's fugitive particulate emissions were excluded from this analysis.

Since no historical exhaust data was available for the Northside Drive facility, the physical exhaust data from Water Street's fabric coating Tower A was assumed to be located at Northside Drive for model input.

Discovery regarding the rate of PFOA emissions from Chemfab's PTFE coating towers is ongoing. To simulate PFOA emissions from Water Street for this analysis, a unit emission rate was input into the model by using a weighted approach based on each tower's fabric width and line speed. Table 3 presents this approach and resulting unit emission rate in pounds per hours. Since only a single stack was simulated at Northside Drive, a unit emission rate of 1 g/s was input into AERMOD. Using unit emission rate inputs, the resulting model output is $\frac{g/m^2/yr}{lb/hr}$. Since AERMOD results are linear, the results can be multiplied by any mass emission rate (g/s or lb/hr) to provide a calculated g/m²/yr. Three PFOA emission rate scenarios were used in this analysis to provide probable upper and lower bound PFOA deposition estimates from the Northside Drive and Water Street facilities. The results of this approach are discussed in Section 5.

4.3. DEPOSITION PARAMETERS

AERMOD is designed to offer the user the option of two methods to simulate particulate matter to determine the wet and dry deposition rates. Method 1 is the US EPA default method that incorporates gravitational settling of the emitted particles. This method would be selected when approximately 10% or more of the modeled particles have a diameter of 10 μm or larger. Method 2 is a non-default option using a simplified approach when the modeled particles have a greater distribution smaller than 10 μm (Wesley, M.L., 2002). Method 2 was selected for this analysis based on the measured particle size distribution of perfluorooctanoate (PFO) at the fence line of a DuPont facility in Parkersburg, West Virginia. (Barton, C.A., 2008, p. 29) These results indicated fine particulate matter with diameter ranges below 4 μm . The representative mass-mean particle diameter required for the Method 2 input was calculated from the Barton particle size distribution of PFO (See Table 4) with a particle density of 1 g/cm^3 .

4.4. RECEPTORS

Figure 3 shows the receptor grid input to estimate the ambient particulate deposition rate concentrations around the two Chemfab facilities. A Cartesian receptor grid with 100-meter spacing was established for the entire modeling domain. The grid is 12 km x 12 km in sized totaling 14,857 receptors.

All coordinates (receptors, building, and emission points) were input into the model using the Universal Transverse Mercator (UTM) coordinate system (NAD 83 datum). Receptor elevations were developed using National Elevation Data set for Bennington, Vermont (NED_92453903) for input and pre-processing by AERMAP.

4.5. METEOROLOGY

Refined modeling was conducted using five years (2006 through 2010) of archived meteorological data. The data set was processed by the VDEC for use in a similar deposition analysis of PFOA emissions from Chemfab's Water Street operations. The data includes meteorological surface data (including precipitation) from the Bennington, Vermont airport and upper air radiosonde data from the Albany, New York International Airport.

5. WET AND DRY DEPOSITION MODELING RESULTS AND DISCUSSION

At this time, the amount of PFOA that was emitted from the Chemfab process is a subject of on-going discovery. For that reason and as discussed in Section 4.2, the approach for this modeling analysis was to use a unit emission rate. The unit deposition rate results can then be applied to any number of PFOA emission rate scenarios linearly. For the purposes of this analysis, two sets of emission rate bounding scenarios were examined (one for each Chemfab facility). For the Water Street facility, the PFOA emission rates were bound using the following three emission rate scenarios:

1. LOWER BOUND 100 LB/YR. This lower bound emission scenario was based on Appendix A of the Barr Draft Conceptual Modeling of PFOA Fate and Transport: North Bennington, Vermont Report. Table A-1 of this appendix presents an estimated average annual emission rate of 145 lb/yr of PFOA from the Water Street operations.
2. 1,000 LB/YR. Table 10 in the Alliance Technologies April 1992 report Chemfab Corporation Diagnostic Test Program Results presents a fluorinated hydrocarbon emission rate of 0.15 pounds per hour from Tower E. Assuming continuous operation, 0.15 pounds per hour from 11 stacks equates to 14,450 pounds per year. Per a May 2, 2017 teleconference with Mr. Phillip Cannata of the VDEC, the VDEC did not believe all of the fluorinated hydrocarbons measured by Alliance Technologies was PFOA - possibly an order of magnitude less. This assumption would equate to 0.015 pounds per hour or 1,445 pounds per year. Mr. Cannata also indicated that during a VDEC discussion with a Chemfab engineer, the engineer roughly estimated 100 pounds of PFOA emitted from each of the 11 stacks per

year, or 1,100 pounds per year. Based on this communication with the VDEC, this analysis included a mid-range PFOA emission rate value of 1,000 pounds per year.

3. UPPER BOUND 10,000 LB/YR. Per the Expert Report of Phillip K. Hopke, Ph.D., upon which I rely: using Barr's annual dispersion usage numbers from Table A-1, but with no destruction of PFOA and no reduction by the abators, the average PFOA emissions would have been nearly 3,000 lbs. per year. If concentrations of APFO in dispersions were taken from Material Safety Data Sheets, instead of the 2,000 ppm concentration assumed by Barr, the annual emissions would have been 7,000 lbs. per year. Similarly, based on dispersion usage for one year in North Bennington (presumably 2000) as presented in a Saint-Gobain spreadsheet prepared for permitting of the towers moved to the Merrimack, NH, plant in 2001, the annual PFOA emissions (assuming 100% released) would have been about 7,000 pounds per year. 10,000 lbs. per year is a reasonable upper bound for the modeling.

For the Northside Drive facility, the PFOA emission rates were bound using the following two emission rate scenarios:

1. LOWER BOUND 50 LB/YR. This lower bound emission scenario was based on Appendix A of the Barr Draft Conceptual Modeling of PFOA Fate and Transport: North Bennington, Vermont Report. Table A-1 of this appendix presents an estimated average annual emission rate of 47 lb/yr of PFOA from the Northside Drive operations.
2. UPPER BOUND 1,000 LB/YR. Per the Expert Report of Phillip K. Hopke, Ph.D., upon which I rely: using Barr's annual dispersion usage numbers from Table A-1, but with no destruction of PFOA and no reduction by the abators, the average PFOA emissions would have been over 400 lbs. per year. If concentrations of APFO in dispersions were taken from Material Safety Data Sheets, instead of the 2,000 ppm concentration assumed by Barr, the annual emissions would have been over 1,000 lbs. per year.

Figure 4 is a portion of a VDEC figure depicting water wells sampled for PFOA and the resulting concentrations in the North Bennington, Vermont area. This figure is used as a base for the modeled deposition contour figures for comparison to deposition modeling results as discussed below.

Figure 5 is a wind rose developed from the five (5) year Bennington Airport meteorological surface data used in this analysis. The wind rose depicts thirty-six (36) sectors of wind vectors or the direction the wind blows towards in the data set. The wind rose shows typical wind patterns for 42° latitude in the eastern United States with winds generally from the northwest, west, southwest, and south-southeast. Wind direction from the east occurs infrequently.

Figures 6, 7, and 8 are the resulting PFOA deposition (wet and dry total) contours from the Water Street operations for the 100, 1,000, and 10,000 pounds per year PFOA emission rate scenarios, respectively. A Google Earth™ image and the VDEC well data figure are used as the base for the deposition contours for visual comparison. The contours for each figure are identical with the amount of PFOA deposition increasing linearly by an order of magnitude with each scenario from 100 to 10,000 pounds per year. The deposition pattern is clearer in Figure 7 when the major and minor contour lines are also presented. The maximum deposition rate for each scenario was indicated by AERMOD to occur only 525 feet east of the Water Street stacks. Moving outward, the deposition pattern lies along the predominating wind directions with higher deposition rates extending more north-northeast, south-southeast, and east of the Chemfab facility. The finger-like extensions of the contours is evidence of AERMOD simulating the deposition of the particles when the plume encounters higher terrain features with a "wrapping" affect. If PFOA was emitted from Chemfab's Water Street operations in the range of 10,000 pounds per year, to a reasonable degree of scientific certainty dry and wet deposition occurred as far away as three (3) miles south, two and one half (2.5) miles east, and four (4) miles north of Chemfab's operation.

Figures 9 and 10 are the resulting PFOA deposition (wet and dry total) contours from the Northside Drive operations for the 50 and 1,000 pounds per year PFOA emission rate scenarios, respectively. With lower emission rate scenarios, the amount of deposited PFOA is likewise less. However, even from the much smaller Northside Drive operation, the extent of deposition is considerable to the north and south directions.

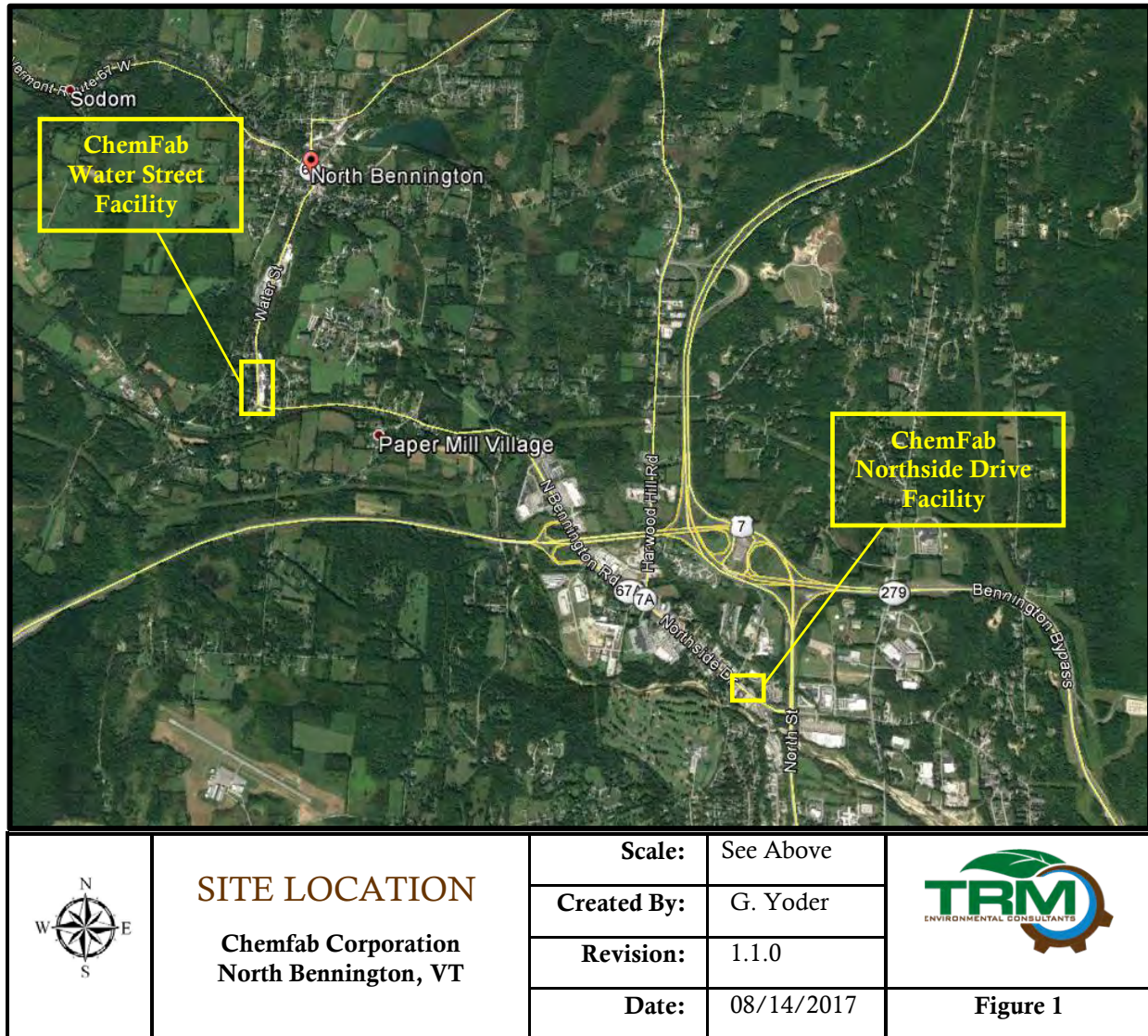
This analysis presents where PFOA would be deposited under three Chemfab PFOA emission rate scenarios for the Water Street facility and two emission PFOA emission rate scenarios for the Northside Drive facility. Based on the AERMOD results and the deposition patterns, to a reasonable degree of scientific certainty PFOA was deposited from Chemfab's operations on land surfaces in the area where PFOA was detected in residential water wells throughout the most recent Vermont DEC Sampling Boundary.

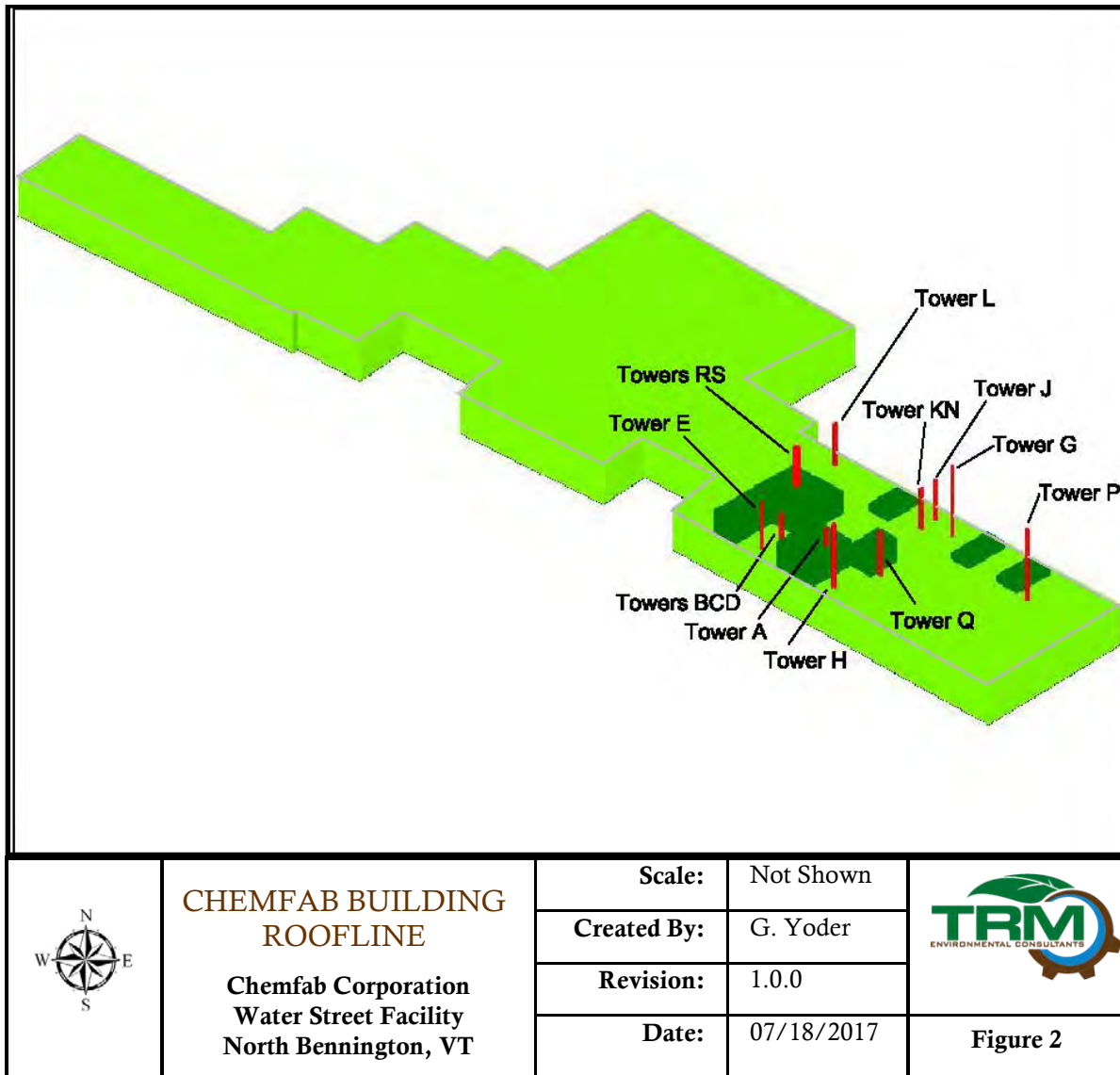
We reserve the right to supplement these professional opinions or modify this report as additional information or data becomes available.

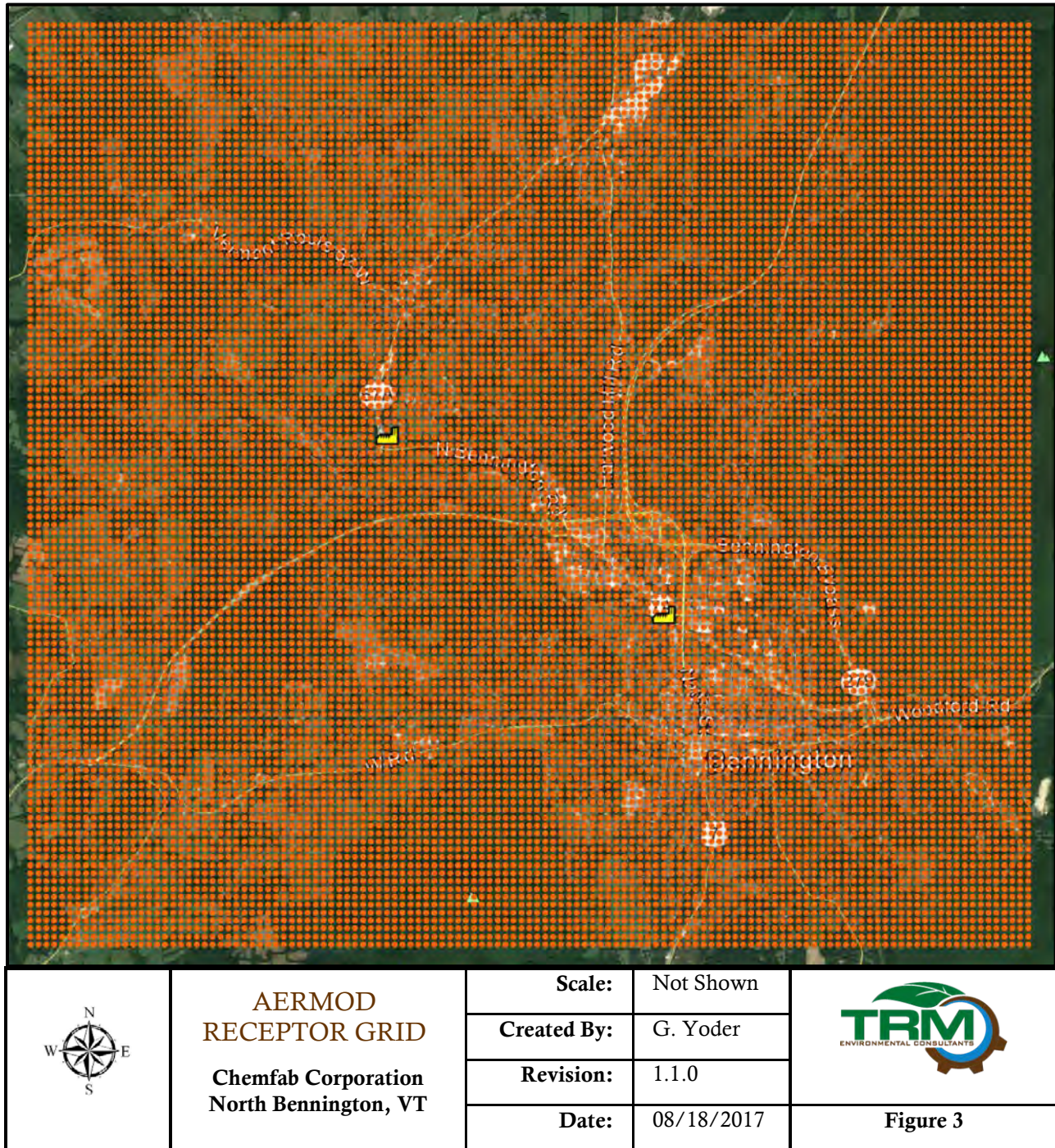
6. CITATIONS

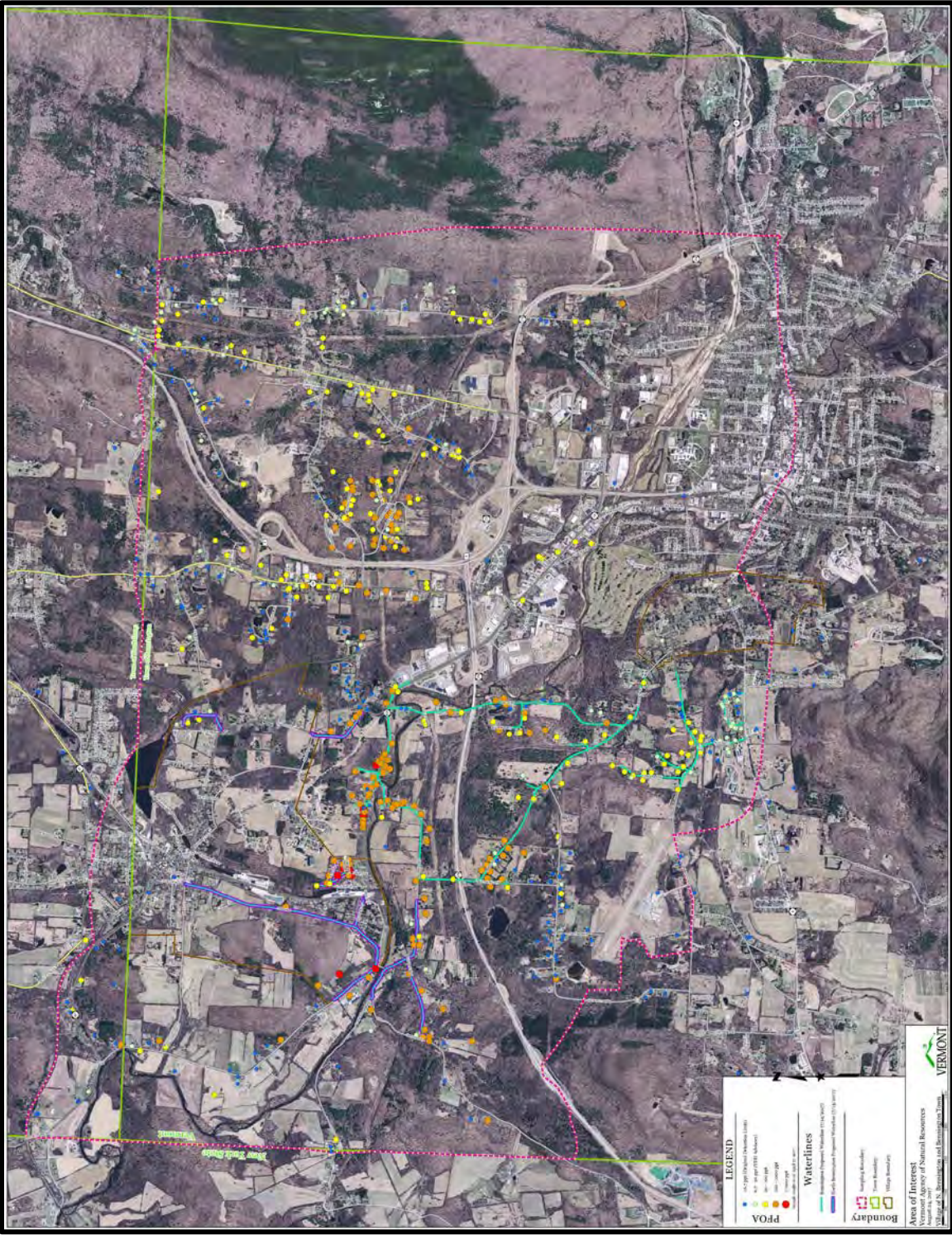
- Barton, Catherine Arundel., *Dissertation Submitted on The Measurement, Partitioning and Near-Field Modeling of Perfluorooctanoate (PFO) in Air*, University of Delaware, 2008, Summer.
- Duncan, Carol Weston, "Memorandum for A2 File, Air Pollution Control Division, On Inspection of Chemfab Corporation to Chris Jones, Compliance Chief," 1998, November 16.
- Etter, Philp., "Memorandum for A2 File, Air Pollution Control Division on Compliance Inspection/Investigation of Chemfab Corporation Through Chris Jones, Compliance Chief," State of Vermont, Montpelier, 1998, November 3.
- Etter, Philp., "Memorandum for A2 File, Air Pollution Control Division on Compliance Inspection of Chemfab Corporation Through Chris Jones, Compliance Chief," State of Vermont, Montpelier, 1999, February 19.
- Jones, Christian B., "Memorandum from State of Vermont, Agency of Environmental Conservation Regarding Chemical Fabrics Corporation, North Bennington – Odor Complaint to Richard A. Valentinetti, Director, Air Pollution Control Program and Reginald A. LaRosa," State of Vermont, Montpelier, 1985: November 26.
- Jones, Christian B., "Memorandum on Stack Testing of Chemfab's Tower R on July 13-15, 1999 To Dick Valentinetti," State of Vermont, Montpelier, 1999, September 20.
- Prohaska, Robert A., "Cover Letter to Douglas Elliott of Vermont Agency of Natural Resources from Chemfab/Saint-Gobain, Manager, HSE & Quality on Catalyst Activity Tests," North Bennington, Vermont, 2000, December 15.
- TRC Environmental Corporation, Lowell, Massachusetts, "Final Report: Emissions Testing on Tower R, CHEMFAB Corporation, North Bennington, VT.," August 1999.
- Wesley, M.L., Doskey, P.V., Shannon, J.D., "Deposition Parameterizations for the Industrial Source Complex (ISC3) Model." Environmental Research Division, The University of Chicago, Illinois: 2002.


FIGURES

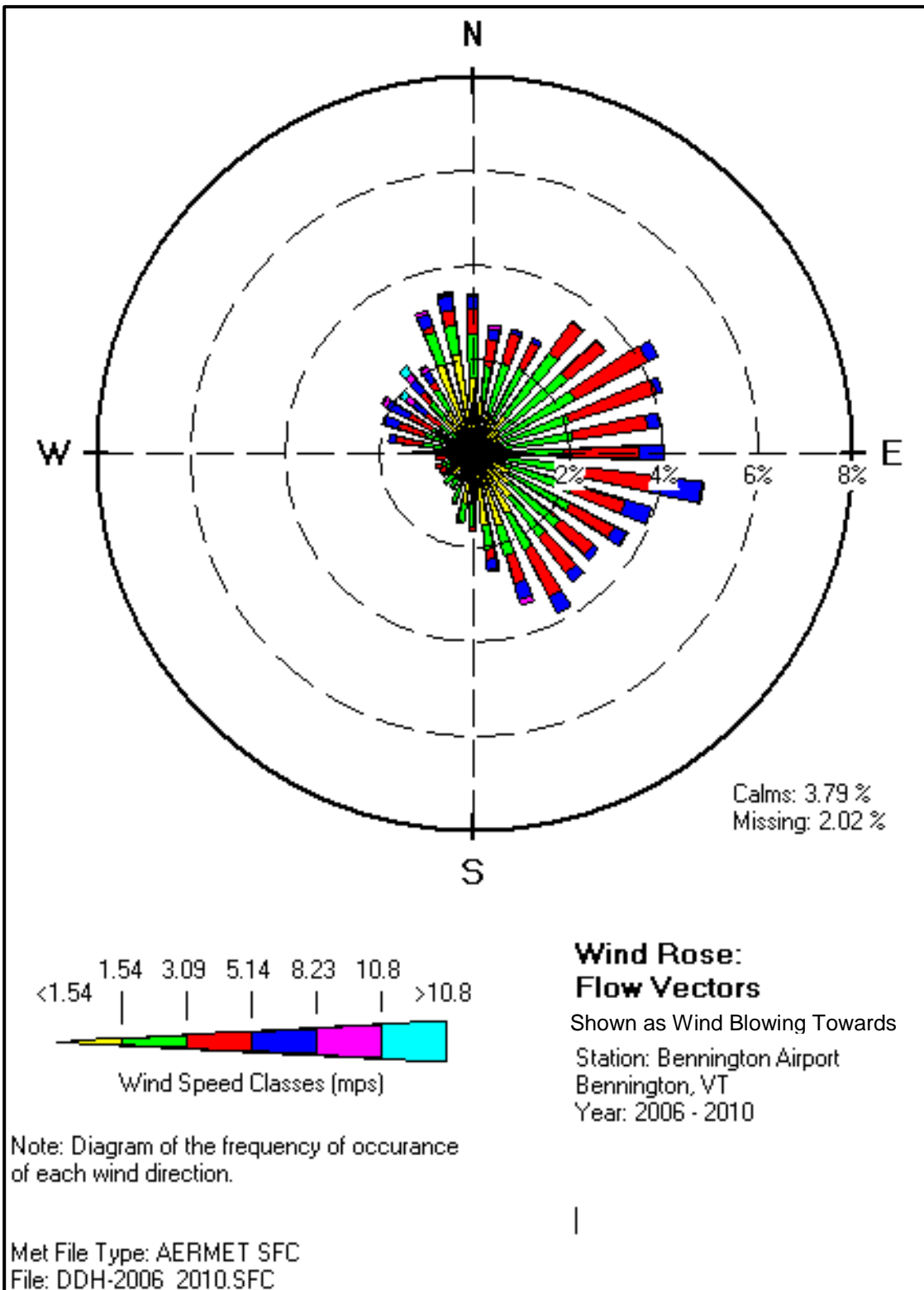








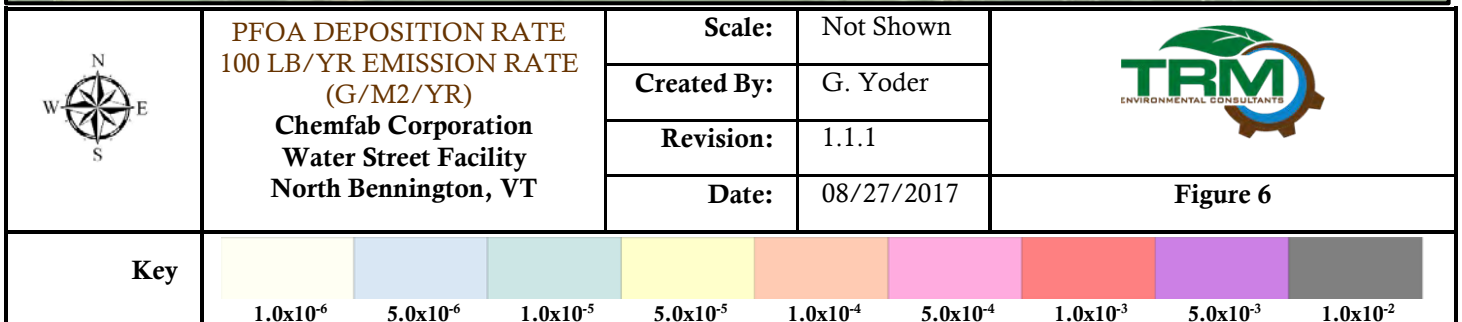
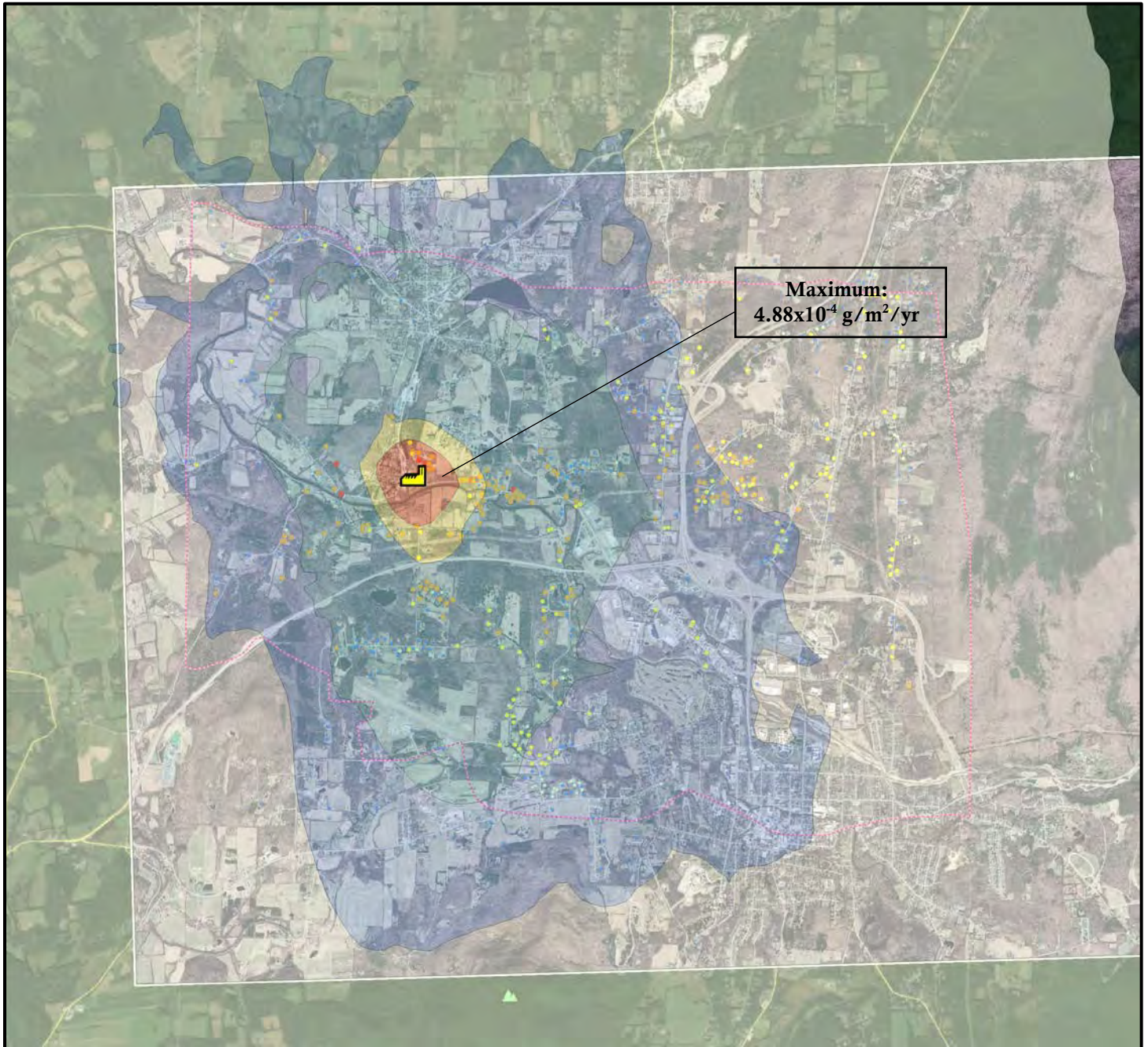


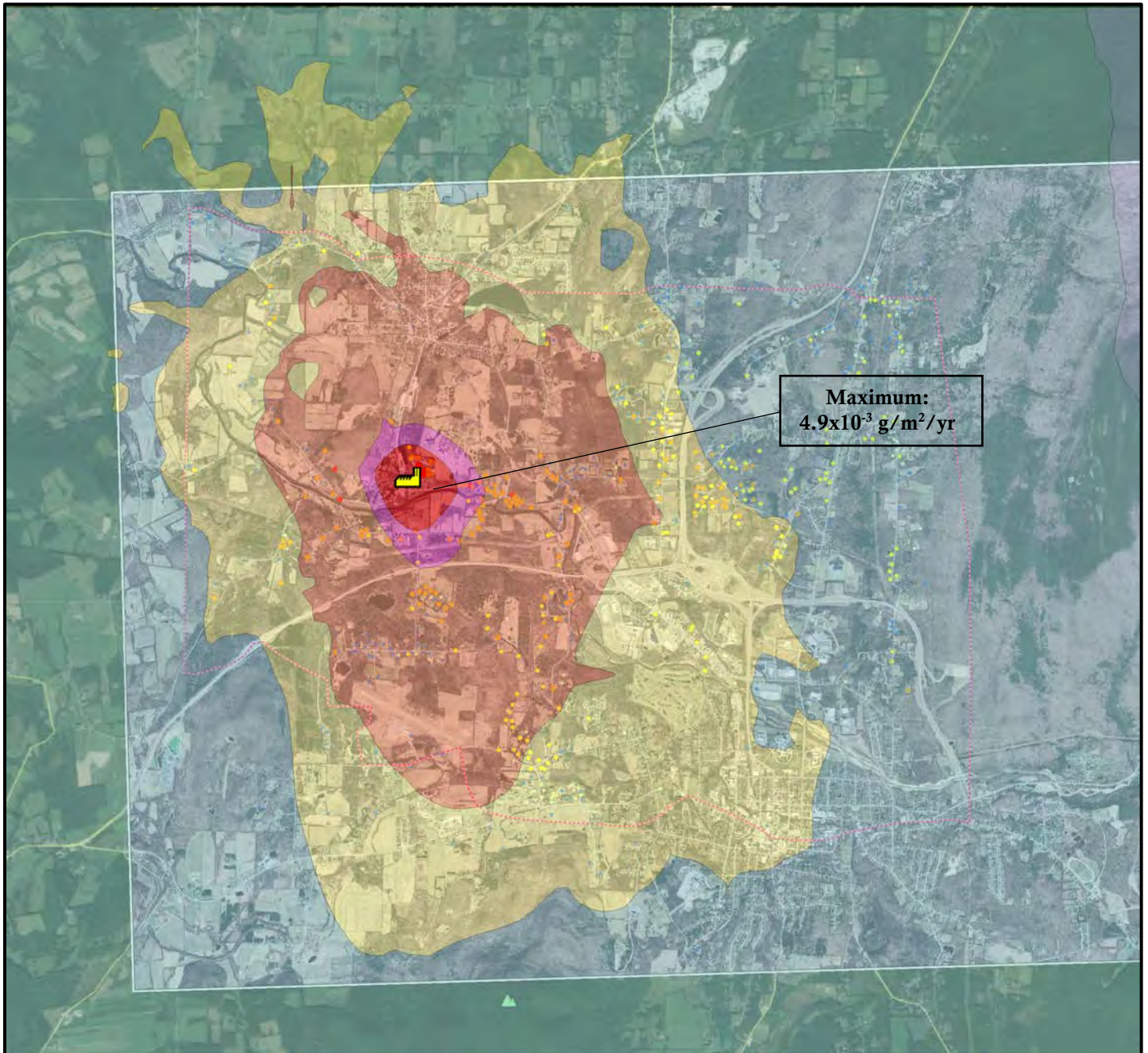
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	Revision:	1.0.0
	Date:	08/24/2017
Figure 4		






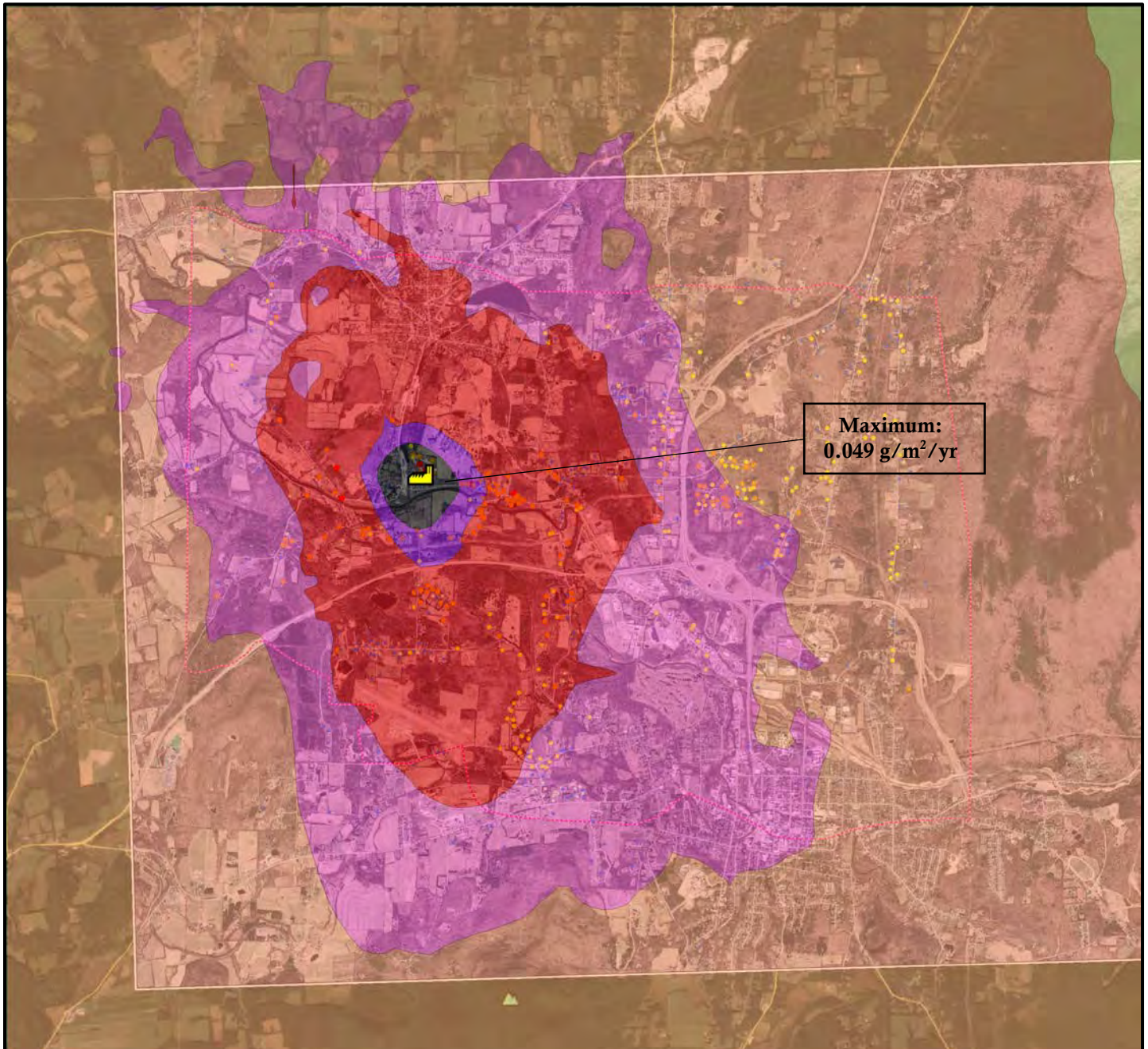
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		Revision:	1.0.0	
		Date:	07/18/2017	
				Figure 5

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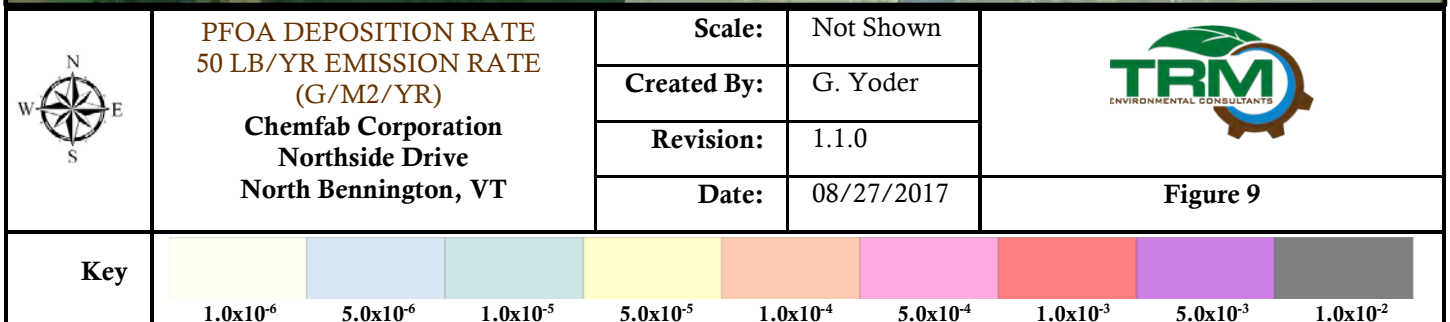
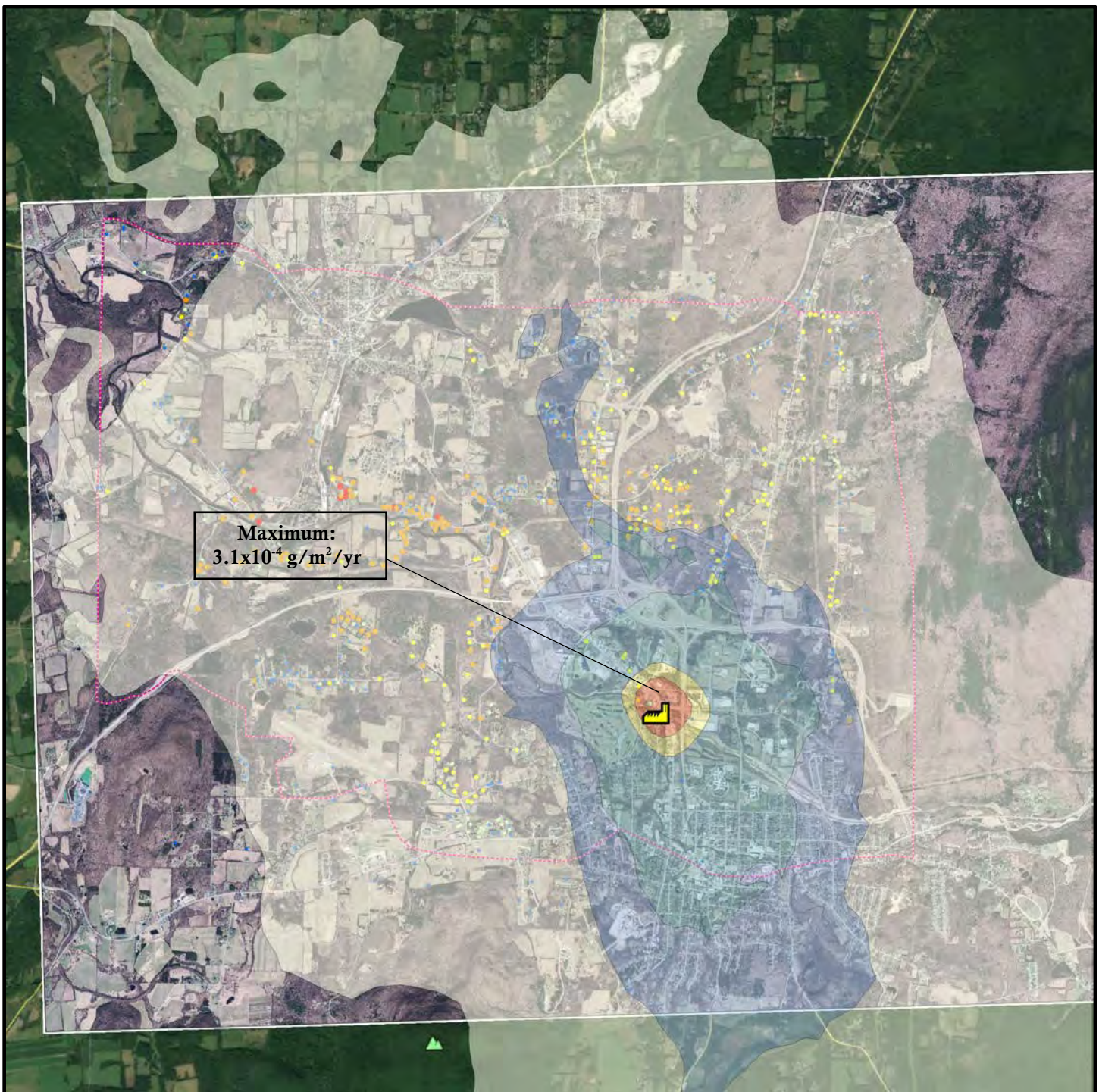


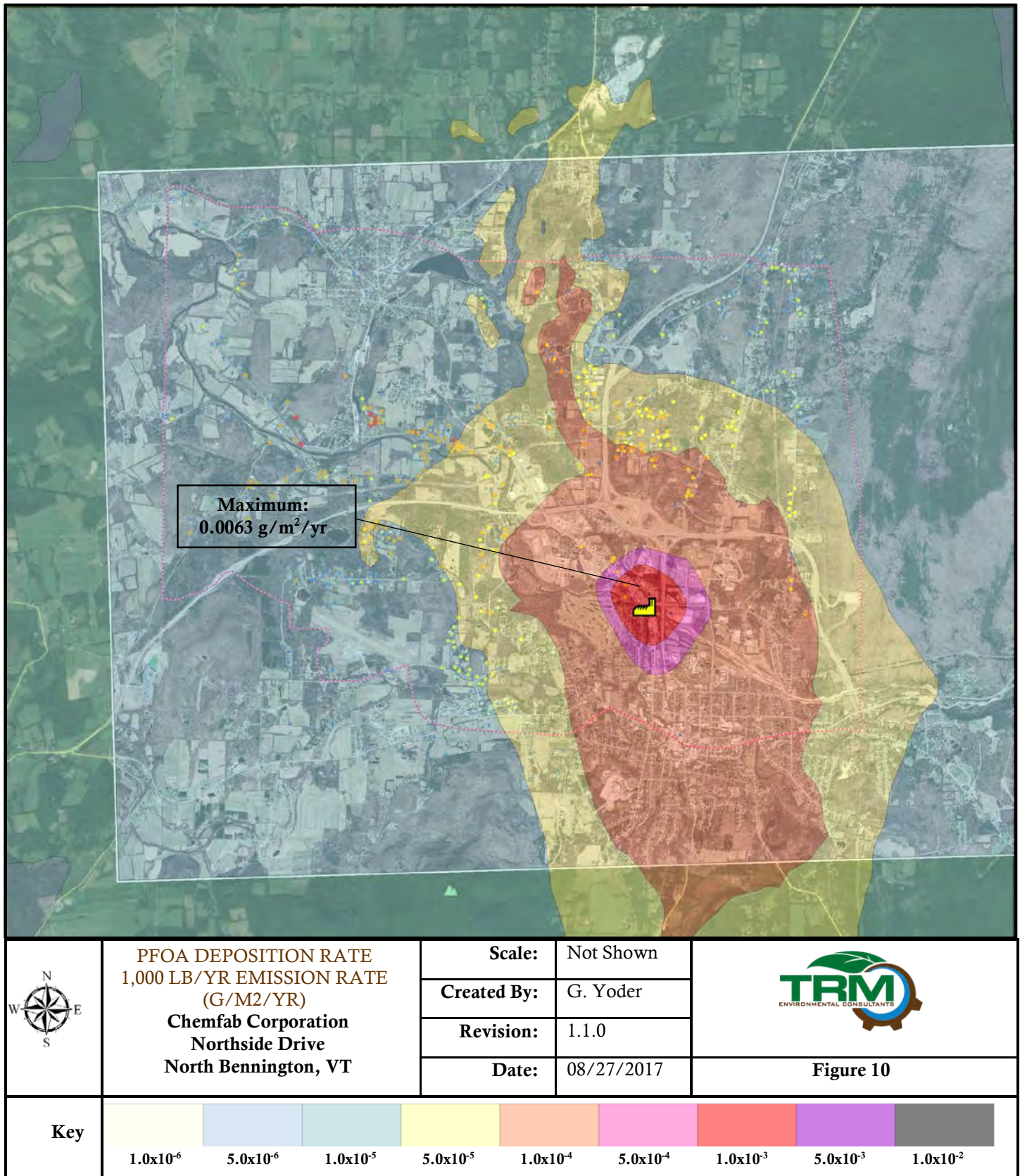


	PFOA DEPOSITION RATE 1,000 LB/YR EMISSION RATE (G/M2/YR) Chemfab Corporation Water Street Facility North Bennington, VT	Scale:	Not Shown	
		Created By:	G. Yoder	
		Revision:	1.1.1	
		Date:	08/27/2017	Figure 7
Key	 1.0x10 ⁻⁶ 5.0x10 ⁻⁶ 1.0x10 ⁻⁵ 5.0x10 ⁻⁵ 1.0x10 ⁻⁴ 5.0x10 ⁻⁴ 1.0x10 ⁻³ 5.0x10 ⁻³ 1.0x10 ⁻²			



	<p>PFOA DEPOSITION RATE 10,000 LB/YR EMISSION RATE (G/M2/YR)</p> <p>Chemfab Corporation Water Street Facility North Bennington, VT</p>	Scale:	Not Shown	
		Created By:	G. Yoder	
		Revision:	1.1.1	
		Date:	08/27/2017	Figure 8
Key				





TABLES

TABLE 1 - BUILDING STRUCTURE INPUT DATA

CHEMFAB CORP.
NORTH BENNINGTON, VT

<u>STRUCTURE</u>	<u>HEIGHT</u>		<u>WIDTH</u>		<u>LENGTH</u>	
	<u>(M)</u>	<u>(FT)</u>	<u>(M)</u>	<u>(FT)</u>	<u>(M)</u>	<u>(FT)</u>
Main Building	10	32.8	78	255.9	270	885.8
RS Penthouse	14.6	48	14.3	46.9	23.5	77.1
A Penthouse	15.9	52	10.4	34.1	11.2	36.7
Q Penthouse	15.9	52	5.5	18.0	8	26.2
J Penthouse	12.2	40	6	19.7	9	29.5
G Penthouse	12.2	40	5.5	18.0	10.8	35.4
P Penthouse	12.2	40	6.4	21.0	10	32.8

TABLE 2 - EMISSION SOURCE MODELING INPUT DATA

CHEMFAB CORP.
NORTH BENNINGTON, VT

<u>STACK ID</u>	<u>EASTING (X)</u> (M)	<u>UTM</u> <u>NORTHING (Y)</u> (M)	<u>BASE</u> <u>ELEVATION</u> (M)	<u>STACK</u> <u>HEIGHT</u> (M)	<u>STACK</u> <u>HEIGHT</u> (FT)	<u>TEMPERATURE</u> (K)	<u>TEMPERATURE</u> (F)	<u>EXIT</u> <u>VELOCITY</u> (M/S)	<u>EXIT</u> <u>VELOCITY</u> (FPS)	<u>VOLUMETRIC</u> <u>FLOW</u> (ACM/S)	<u>VOLUMETRIC</u> <u>FLOW</u> (ACFM)	<u>STACK</u> <u>DIAMETER</u> (M)	<u>STACK</u> <u>DIAMETER</u> (FT)
TOWERA	643131.6	4752837.6	167.0	20.7	68	575.2	575.6	7.17	23.5	0.925	1960.0	0.41	1.3
TOWERBCD	643128.5	4752847.6	167.2	20.7	68	574.8	575.0	7.92	26.0	2.310	4900.0	0.61	2.0
TOWERE	643128.3	4752853.1	167.3	20.7	68	574.8	575.0	12.94	42.4	7.400	15680.0	0.85	2.8
TOWERG	643159.5	4752828.4	165.9	28.3	93	422.0	300.0 ¹	5.24	17.2	3.070	6500.0	0.86	2.8
TOWERH	643129.0	4752832.7	167.0	25.3	83	574.8	575.0	1.78	5.8	0.925	1960.0	0.81	2.7
TOWERJ	643160.8	4752834.8	165.9	20.7	68	574.8	575.0	7.17	23.5	0.925	1960.0	0.41	1.3
TOWERK&N	643156.6	4752834.5	166.0	20.7	68	574.8	575.0	7.17	23.5	0.925	1960.0	0.41	1.3
TOWERL	643160.3	4752863.7	166.1	20.7	68	574.8	575.0	11.35	37.3	2.790	5900.0	0.56	1.8
TOWERP	643154.2	4752801.4	165.9	28.3	93	422.0	300.0 ¹	2.66	8.7	1.560	3300.0 ²	0.86	2.8
TOWERQ	643139.0	4752828.9	166.6	20.7	68	574.8	575.0	1.78	5.8	0.925	1960.0	0.81	2.7
TOWERRS	643143.7	4752858.3	166.7	25.0	82	422.0	300.0 ¹	0.71	2.3	1.800	3814.0 ³	1.80	5.9

NOTES:

- 1. Tower stacks G, P, and RS are designed for entrainment dilution. With this design, a decrease at exhaust release from 575°F to 300° F was assumed.
- 2. From July 1998 stack test.
- 3. From July 1999 stack test.

TABLE 3 - UNIT EMISSION RATE WEIGHTING

CHEMFAB CORP.
NORTH BENNINGTON, VT

<u>TOWER ID</u>	<u>WIDTH</u>		<u>RATE</u>		<u>WEIGHTED RATE</u>	<u>AERMOD UNIT EMISSION RATE INPUT AS PM-2.5</u>
	<u>(IN)</u>	<u>(FT)</u>	<u>(FPM)</u>	<u>(FT²/MIN)</u>	<u>(FT²/MIN)</u>	<u>(G/S)</u>
A	46	3.83	20	76.7	0.0233	0.0233
B	46	3.83	20	76.7	0.0233	
C	46	3.83	20	76.7	0.0233	0.0832
D	72	6.00	20	120.0	0.0365	
E	180	15.00	5	75.0	0.0228	0.0228
G	180	15.00	10	150.0	0.0456	0.0456
H	44	3.67	15	55.0	0.0167	0.0167
J	45	3.75	12	45	0.0137	0.0137
K	45	3.75	12	45.0	0.0137	
N	46	3.83	20	76.7	0.0233	0.0370
L	92	7.67	15	115.0	0.0350	0.0350
P	180	15.00	120	1800.0	0.5477	0.5477
Q	46	3.83	30	115.0	0.0350	0.0350
R	92	7.67	30	230.0	0.0700	
S	92	7.67	30	230.0	0.0700	0.1400
Total				3286.7	1.0	1.0

TABLE 4 - PFO MEAN-MASS PARTICLE SIZE DIAMETER

CHEMFAB CORP. NORTH BENNINGTON, VT						
<u>PARTICLE SIZE</u> <u>DISTRIBUTION</u> <u>RANGE¹</u> (μ M)	<u>MASS</u> <u>FRACTION</u>	<u>NATURAL</u> <u>LOGARITHM OF</u> <u>GEOMETRIC</u> <u>MIDPOINT</u>	<u>EXPONENTIAL</u>	<u>NATURAL LOG/</u> <u>HIGH RANGE</u> <u>PRODUCT</u>	<u>WEIGHTED</u> <u>MIDPOINT</u> (μ M)	
>4	7	5.6	7	7	39.2	
1.7	1.7	12.9	0.708	2.029	3.450	44.500
0.8	0.8	9.2	0.377	1.458	1.166	10.729
0.5	0.5	7.2	0.235	1.265	0.632	4.554
0.3	0.3	5.3	0.255	1.291	0.387	2.053
<0.28	0.2	59.8	0.203	1.225	0.245	14.648
Sum					115.684	
Mean-Mass PD (Sum/100)					1.157	

NOTE:

Derived from:

Barton, C. A, Dissertation Submitted on *The Measurement, Partitioning and Near-Field Modeling of Perfluorooctanoate (PFO) in Air*, University of Delaware, 2008, Summer, p. 29.

APPENDIX A
AUTHOR'S PROFESSIONAL RESUME

GARY T. YODER

Vice President of Environmental Services
ClimeCo Corporation



EDUCATION

Master of Science – Meteorology, North Carolina State University, 1992
Bachelor of Science – Geography/Pre-Meteorology, Ohio University, 1988

MEMBERSHIPS / COURSE INSTRUCTION

American Meteorological Society, Member

Carolinas Air Pollution Control Association, Member

"Industry Perspective of An Air Toxics Study: Ambient Toluene Isocyanate Concentrations From Flexible Polyurethane Foam Manufacturing"
CAPCA Spring Conference, 2008

Air Dispersion Modeling
NC Toxics Air Pollutants Workshops, 1993

EXPERIENCE SUMMARY

Gary T. Yoder has over 23 years of professional air quality experience providing compliance services to the manufacturing, utility, government, and institutional market sectors. Mr. Yoder is a senior-level scientist whose primary areas of technical expertise are air dispersion modeling, regulatory applicability and consultation, emission estimation, air pollution control applications, and emission measurement management. Throughout his career, Mr. Yoder has assisted multiple manufacturing operations with air quality compliance solutions in many states along the east coast. His projects have involved complex air quality issues pertaining to federal NSPS, NESHAP, MACT, PSD, NNSR, and Title V, as well as various state regulations.

Mr. Yoder's air quality assessment expertise includes:

- Emission Inventories
- Compliance Auditing
- Air Dispersion Modeling
- Monitoring System Design
- Recordkeeping / Reporting System Design
- Air Permit Application Development
- Air Pollution Control Applications
- Regulatory Applicability and Consultation
- Air Emissions and GHG Inventories

Expert Testimony / Court Expert Assistance

Expert Witness Testimony (Deposition) – Penn Township Zoning Board, 02/11/2016
Expert Witness Testimony (Deposition) – Lee County Board of Adjustments, 10/14/2015

PROJECT HIGHLIGHTS

- Biomass Boiler Construction Air Permitting – Sanford, North Carolina
- Ag-Methane Digester Project Construction Air Permitting – San Joaquin Valley, California
- Ambient TDI Sampling Studies for the Foam Manufacturing Industry – North Carolina
- Air Intake Entrainment Studies for Stack Design – North Carolina
- Air Dispersion Modeling Analyses – Multi-State
- Major Source Operating Permit Applications – Multi-State
- Monitoring, Recordkeeping, and Reporting System Development – Multi-State
- Highway Air and Noise Impact Analyses – Multi-State

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